U.S. Department of Transportation
Federal Aviation Administration

Memorandum

Subject: **INFORMATION**: Policy for Propeller-Level Failure Effects

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From: Manager, Engine and Propeller Directorate, Aircraft Certification Service

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Manager, Atlanta Aircraft Certification Office, ACE-115A
Manager, Airframe and Propulsion Branch, ACE-117A
Manager, Chicago Aircraft Certification Office, ACE-115C
Manager, Propulsion Branch, ACE-118C
Manager, Wichita Aircraft Certification Office, ACE-115W
Manager, Systems and Propulsion Branch, ACE-116W
Manager, Anchorage Aircraft Certification Office, ACE-115N
Manager, Transport Airplane Directorate, ANM-100
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1. Purpose

Many new propeller certification programs include composite blades and spinners and electronic controls. Part 35 of Title 14 of the Code of Federal Regulations (14 CFR part 35) does not have explicit safety standards for the substantiation of propellers with composite blades and spinners for bird strike, lightning strike, and centrifugal loads, nor does it address electronic controls and safety assessment. The safety standards for these design features and analyses have been incorporated into the propeller certification basis by issuing special conditions. Until rulemaking is finalized to incorporate these standards into part 35, individual propeller certifications that contain these novel or unusual design features must continue to be addressed with special conditions. This policy provides guidance for the development of those special conditions with regard to propeller-level failure effects.

2. Related Documents

a. Advisory Circulars.

(1) AC 25.1309-1A, System Design Analysis, dated 6/21/88.

(2) AC 23.1309-1C, Equipment, Systems, and Installations in Part 23 Airplanes, dated 3/12/99.

b. Policy.

Policy No. 1999-33/35-R0, Policy for Rule and Advisory Material Development under Title 14 of the Code of Federal Regulations (14 CFR) Parts 33 and 35, dated 5/24/99.

3. Background

a. The "Policy for Rule and Advisory Material Development under Title 14 of the Code of Federal Regulations (14 CFR) Parts 33 and 35" establishes that the part 35 certification procedures address a single propeller and that the effects of failures should be assessed at the propeller level. Once the propeller passes into the certification environment of the aircraft, specifics of the particular installation are used to address the issues of powerplant redundancy or the effects of various failures. Offices with aircraft certification authority (under parts 23, 25, 27 or 29) regulate the aircraft-level effects of all parts of the aircraft, including the propellers.

b. Aircraft-level failure classifications are not directly applicable to propeller failure classifications because the aircraft may have features that could decrease or increase the consequences of a propeller failure effect. Additionally, the same type-certificated propeller may be used in a variety of installations, each with different aircraft-level failure classifications.

c. Due to installation differences, aircraft-level requirements for individual failure conditions may be more severe than the propeller-level requirements. Therefore, the propeller manufacturer and the aircraft manufacturer should coordinate with each other, as well as with the appropriate FAA certification offices, to ensure that the propeller installation is acceptable. The FAA strives to ensure that the propeller applicant is aware of the possibility of more restrictive regulations in the installed condition.

4. Propeller-Level Failure Effects

a. Hazardous propeller effects. The following are considered hazardous propeller effects:

(1) Significant overspeed of the propeller.

(2) Development of excessive drag.

(3) Significant thrust in the direction opposite to that commanded by the pilot.

(4) Release of the propeller or any major portion of the propeller.

(5) Failure that results in excessive unbalance.

(6) Unintended movement of the propeller blades below the established minimum in-flight low-pitch position.

b. Major propeller effects. The following are considered major propeller effects for variable pitch propellers:

(1) Inability to feather the propeller (for feathering propellers).

(2) Inability to change propeller pitch.

(3) Significant uncommanded change in pitch.

(4) Significant uncontrollable torque or speed fluctuation.

5. Hazardous Propeller Effects

a. Significant overspeed of the propeller. Propeller failures resulting in significant overspeed, depending on the flight phase, could result in a hazardous condition related to aircraft controllability and engine damage. Overspeeds are generally caused by unwanted low propeller pitch during flight.

b. Development of excessive drag or significant thrust in the direction opposite to that commanded by the pilot. Propeller failures resulting in excessive drag or significant thrust in the direction opposite to that commanded by the pilot could, depending on the flight phase, result in a hazardous condition related to aircraft controllability. Failures that could be classified as hazardous effects include unwanted low or reverse propeller pitch in flight and high forward thrust when reverse thrust is commanded.

c. Release of the propeller or any major portion of the propeller. The release of the propeller, blades, hubs, counterweights, erosion shields, and other similar large rotating components with sufficient energy to penetrate a fuselage should be considered a hazardous propeller effect.

d. Failure that results in excessive unbalance. Propeller failures resulting in excessive unbalance could result in a hazardous condition related to aircraft and engine damage. Failures that result in excessive unbalance include:

(1) Release of a blade;

(2) Release of a major portion of a blade;

(3) Release of a counterweight; and

(4) Unwanted pitch change of individual blades.

The propeller may have mitigating features that reduce the unbalance effect of unwanted pitch change of individual blades, such as counterweights that drive the propeller to a fail safe condition or the ability to feather the remaining blades and reduce the unbalance of the propeller.

e. Unintended movement of the propeller blades below the established minimum in-flight low-pitch position. This type of failure could disrupt the airflow over the wing, potentially leading to an increased stall speed.

6. Major Propeller Effects

a. Inability to feather the propeller (for feathering propellers). The propeller should be able to reach the established feather angle. The rate of pitch change to reach the feather angle should not be substantially lower than that of the normally operating system.

b. Inability to change propeller pitch. The propeller should be considered to be unable to change pitch when the rate of pitch change is substantially lower than that of the normally operating system.

c. Significant uncommanded change in pitch. A significant uncommanded change in pitch is one that would require pilot corrective action or would significantly degrade aircraft performance. To facilitate propeller system design and certification in the absence of an application-specific definition, significant uncommanded change in pitch is defined as a change that would result in change in thrust of more than 10 percent of the typical climb thrust. However, final determination of the installation requirement is based on aircraft controllability requirements and should be evaluated during aircraft certification.

d. Significant uncontrollable torque or speed fluctuation. A significant uncontrollable torque or speed fluctuation is one that would require pilot corrective action or would significantly degrade aircraft performance. To facilitate propeller system design and certification in the absence of an application-specific definition, significant uncontrollable torque or speed fluctuation is defined as the loss of the capability to modulate rotational speed or torque within 3 percent of reference torque or speed at all normal operating conditions.

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